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INCREASED R&D EXPENDITURES AND ABNORMAL RETURNS

-Evidence from Nordic Markets

Bachelor's Thesis
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Abstract

I study the effects between significant R&D expenses and abnormal returns in the listed Nordic companies. The main objective of the study was to answer whether investors mis-value R&D investments represented by significant R&D increases. The initial hypothesis was that investors underreact to the R&D investments and abnormal positive return predictability exists.

I used Eberhart et al (2004) to define significant R&D increases in companies listed in Finland, Denmark, Sweden, or Norway. Accounting and price data were acquired from Datastream & Thomson Reuters. I then constructed equal weighted, value weighted and long-short portfolios which I regressed using various factor regressions (Fama, French: 1995, 2015, Carhart: 1997).

I found that significant abnormal returns were present in equal weighted companies and the abnormal returns were consistent across portfolios and regressions. Value weighted portfolios produced economically significant returns excluding the long-short portfolio. To control for industry and firm characteristics, I created pre-R&D increase and non- high technology subsample returns and I found that lower technology companies did not exhibit abnormal returns and that the firm performance before R&D increases was not significantly higher or lower.

To control for alternative return explanations, I checked if the firms with R&D increases had significant market exposure during stock market turmoil. I found that firms did not have increased exposure to negative market conditions. In addition, I regressed two subsamples that were separated by an outlier in accounting figures. I found that the abnormal returns were not affected by this outlier.

My results show that positive return predictability applies only to the smaller companies that operate in high technology industries. I interpret positive return predictability as investor underreaction to future benefits of R&D investments in these companies. This phenomenon is not applicable to large companies which show no predictability but show return characteristics with low book to market ratio companies which indicate that these firms contain intangible value and investors perceive positive prospects for them with respect to future performance.

This study provides additional empirical evidence on the growing body of literature on R&D return predictability and how investors react to intangible information by providing an empirical test on the intangible information that is contained within significant increases in R&D expenditures.

Keywords Research and Development, Abnormal Returns, Intangible Information

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1. Introduction

Research and Development (R&D) is a key part of value creation in modern companies. Without sufficient R&D activities or acquiring innovations, companies undermine their competitive abilities on the market. However, R&D investments are costly, and the benefits of the investments are uncertain, compared to other investment activities such as capacity expansions.

The role of research and development in firm value has been studied extensively during the last decades, with many researchers addressing the question of market valuation of R&D investments. Empirical literature provides mixed evidence on the matter. Researchers have found that R&D is mis-valued by the markets and that there exists positive return predictability with R&D investments (Chan, Martin, Kensinger: 1990, Chan, Lakonishok, Sougiannis: 2001, Eberhart, Maxwell, Siddique: 2004, Cohen, Diether, Malloy: 2013). On the other hand, there is a growing body of literature that finds R&D investments associated with increased risk and thereby explaining the return predictability with risk premia (Berk, Green, Naik: 2004, Gu: 2015, Li: 2011, Zhang: 2015).

In this study I will address the question if markets mis-value R&D investments in the Nordics, I find Nordic markets a particularly apt sample for this study due to the similar accounting methods which allows a better comparability over time (Agami, Monsen: 1995). I will follow Eberhart et al (2004) methodology by creating portfolios that contain companies that have large and unexpected increases in R&D expenditure and measuring abnormal returns through Fama French three-factor, five-factor and Carhart four-factor models (Fama, French: 1993, 2015, Carhart: 1997). Most of the literature focuses on US markets and therefore my study contributes international empirical evidence on the subject.

The results indicate that there is some positive return predictability with R&D increases, since equal weighted portfolios produce significant abnormal returns consistently, while value weighted portfolios produce economically large but statistically insignificant returns consistent with Eberhart et al (2004) findings. After controlling for increased systematic risk through market betas during bear markets, I do not find that R&D intensive firms are exposed to increased systemic risk, but instead have reduced market beta during times of stock market downturn. However, these effects are not applicable to all stocks. It seems that smaller firms in high technology industries are subject to positive R&D return predictability.

This study contributes to the growing field of literature that investigates the link between stock returns and R&D by providing empirical evidence on the phenomenon in the Nordic markets. Additionally, this study contributes to the broad field of literature that investigates how markets react to intangible information by providing evidence through a test on how markets react to the intangible information that is contained within large increases in R&D expenditures.

2. Empirical Framework and Hypothesis

The key research question of this paper is whether investors mis-value R&D investments in the Nordics. In this section I will provide and summarize the key literature that I have considered when formulating my hypothesis and what factors should be considered when testing the hypothesis. To my knowledge most of the literature focuses heavily on the US markets with some international counterparts, while specific regions such as the Nordics have not yet received attention.

2.1 Intangibility of R&D Benefits

Although R&D is an investment decision, it is much harder for investors to evaluate its benefits compared to other investments. For example, it is much harder to measure the additional cash flows that are brought in by a new medicine than it is to measure the benefits of an increase in production capacity. These intangible benefits are contrasted by the tangible cost of R&D. Unlike regular investments, R&D is usually expensed instead of amortized, which provides a tangible cost for the investment.

Daniel & Titman (2006) show that investors mis-value intangible information in companies which in turn results to negative return predictability, in addition their results are consistent with the behavioral explanation that investors are overconfident in their abilities to predict intangible information. However, it seems that investor overreaction which presents itself as a negative return relation is not observed when looking at increases in R&D expenses. Instead there seems to be investor underreaction towards R&D increases and that large R&D investments generate tangible benefits by providing significant increases in firm performance. (Chan, Lakonishok, Sougiannis: 2001, Eberhart, Maxwell, Siddique: 2004, Cohen, Diether, Malloy: 2013).

2.2 R&D Expenditures in Predicting Future Returns

R&D as a return predictor has been widely discussed in the empirical literature. The general findings in the empirical literature support that increased R&D expenses predict future returns (Chan, Martin, Kensinger: 1990, Chan, Lakonishok, Sougiannis: 2001, Eberhart, Maxwell, Siddique: 2004, Li: 2011, Cohen, Diether, Malloy: 2013, Zhang: 2015, Gu: 2015). However, the specific mechanisms behind the return predictability are under debate.

Some of the empirical literature attribute the return predictability as market mis-valuation of the intangible benefits provided by R&D (Chan, Lakonishok Sougiannis: 2001, Eberhart, Maxwell, Siddique: 2004, Cohen, Diether, Malloy: 2013). This mis-valuation is usually observed as a market underreaction, which in turn results in positive abnormal returns. However, there is mixed evidence if this underreaction applies to all companies. Chan et al (2001) found that technology firms with poor performance and high R&D intensity generate positive abnormal returns and this effect is not present in other firms. Eberhart et al (2004) in turn found evidence that R&D predicts positive abnormal returns in all stocks through a different definition of R&D intensive stocks and that R&D intensive firms are associated with abnormal growth in operating performance, providing evidence on how the intangible benefit of R&D investments are realized.

Risk-based explanations argue that R&D investment is not in fact mis-valued by markets and that R&D intensive firms are riskier, because the outcomes of R&D projects are uncertain, and they require constant funding in order to be completed. This constant funding can be an issue for companies with financial constraints, and therefore a higher expected return is required due to the risk premium (Li: 2011, Zhang: 2015). However, alternative risk-based evidence exists that explains return predictability by increased systematic risk, because benefits of R&D investments are realized in future cash flows that expose the firms to systematic risk (Berk, Green, Naik: 2004, Gu: 2015).

To summarize, direct mechanisms behind R&D return predictability are still under debate, with many attributing it to investor mis-valuation, while alternative explanations suggest a risk-based mechanism (Chan, Martin, Kensinger: 1990, Chan, Lakonishok, Sougiannis: 2001, Eberhart, Maxwell, Siddique: 2004, Li: 2011, Cohen, Diether, Malloy: 2013, Zhang: 2015, Gu: 2015).

2.3 Hypothesis

My hypothesis relies on two arguments that rely on established phenomena in the scientific literature which are: investor mis-valuation of intangible information and positive R&D return predictability.

Investors have difficulties in evaluating intangible information which is reflected in stock returns (Daniel, Titman: 2006). Since the benefits of R&D investments are tied to future cash flows and the project outcomes are uncertain, the benefits can be seen as intangible and hard to interpret (Eberhart, Maxwell, Siddique: 2004, Chan, Lakonishok, Sougiannis: 2001, Cohen, Diether, Malloy: 2013). However, the mis-valuation does not imply that the return predictability should be positive which I will elaborate on my second argument.

Secondly, the significant R&D increases imply that firms are allocating a lot of capital into something that is considered risky which is understood by the investors. However, investors do not correctly value the benefits, or they allocate too much risk to the R&D investments which results in undervaluation of the R&D investments which is then corrected in the subsequent years followed by the investment. (Eberhart, Maxwell, Siddique: 2004, Chan, Lakonishok, Sougiannis: 2001, Cohen, Diether, Malloy: 2013).

To summarize, I argue that investors are not able to value intangible information and when it comes to large R&D investments, they seem to take a pessimistic stance on the benefits of the R&D investments such as increases in operating performance. These arguments are based on earlier empirical evidence (Daniel, Titman: 2006, Eberhart, Maxwell, Siddique: 2004, Chan, Lakonishok, Sougiannis: 2001, Cohen, Diether, Malloy: 2013). From this I formulate my hypothesis which is shown below.

H1: R&D increases generate positive long-term abnormal returns in the Nordic markets because investors underreact to the benefit that these R&D investments provide.

3. Data

I describe below justification for using Nordic accounting data and the process of sample selection. Price and accounting data were acquired from Datastream and Thomson Reuters and factor datasets were acquired from Kenneth R. French's Data Library[1] and AQR Fund Management's[2] open source datasets.

3.1 Nordic Accounting Standards

Since this thesis relies heavily on accounting data, it is prudent to review how different Nordic countries account standards are comparable. If the historical reporting standards between countries is vastly different, then the key figures used to construct sample data would essentially be incomparable between countries and this would in turn render the analysis section on a fragile foundation.

I will justify the comparability of Nordic accounting data through the study that measures the harmonization of Nordic accounting standards (Agami, Monsen, 1995). In short, Nordic accounting standards have had a high level of harmonization since mid-20th century. This harmonization across countries also includes the reporting of R&D expenditures and the possibility to amortize them. It is important to note that the introduction of IAS/IFRS does change the accounting standards between countries and that this could result in inconsistencies in the data which I will address in section 6.

3.2 R&D Increase Sample Selection Criterion

To investigate my hypothesis, I need to describe R&D increases in a way that it resembles a firm event in addition to a firm characteristic that R&D is usually seen as. Therefore, instead of measuring R&D intensity figures such as R&D to assets, I need to measure the level of change in these R&D intensity figures. By measuring significant increases, I am able to pinpoint "events" where R&D is increased significantly.

Criterion behind the significant R&D increases is arguably the most defining action in this study. Firstly, I need to define the metrics used that measure significant R&D increases. I will use Eberhart

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[1] Kenneth R. French data library can be accessed through: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html
[2] AQR Fund Management provides their factor data in their insights section: https://www.aqr.com/Insights/Datasets

et al (2004) methodology to define two key metrics that are used to measure firms R&D increases. These metrics are: R&D/Sales, R&D/Assets. Since R&D/Sales can be a rather noisy variable due to changes in revenue, it is prudent to also include R&D/Assets variable to measure changes in firm's R&D intensity. In order to measure a significant R&D increase a firm must have at least 5% increase in R&D/Sales and R&D/Assets and R&D/Assets has to be at least 5% after the increase. Finally, 5% increase in R&D expenses is required.

3.3 Sample & Descriptive Statistics

I gathered my sample data from Thomson Reuters and Datastream. Full sample includes companies that have had R&D expenditures in their accounting data and that they have been listed in Finland, Denmark, Sweden, or Norway. The sample includes delisted companies to adjust for any survivorship bias. REIT stocks and financial stocks such as banks and investment firms are excluded from the sample.

Table 1

Below table shows summary statistics on sample firm characteristics listed in Finland, Denmark, Sweden, or Norway. Observation periods starts from 1974 and ends in 2019 and the observation number represents firm year observations. Description of the metrics are the following. RDA measures R&D expenditures relative to the firm's total assets. RevGrwth is the annual revenue growth measured in percentages. Size is the total market capitalization measure in millions of euros. BM is the book to market ratio which is calculated by dividing the shareholder's equity with the market capitalization of the firm. DE measures debt to equity ratio of the firm, the metric is calculated by dividing the total liabilities with the shareholder's equity. Accounting data that was published before initial public offerings were excluded to ensure data quality.

Summary Statistics Full Sample

Metric	Min	Max	Median	Mean	1st quarter	3rd quarter
RDA	0	6,95	0,004	0,046	0	0,038
RevGrwth	-1	8134,3	0	0,7	-0,01	0,12
Size	0,02	232703,1	98,72	1065,62	26,57	477,08
BM	0	137,2	0,6	1,22	0,31	1,08
DE	0	390,1	1,08	1,55	0,56	1,73

Number of observations = 11381

There are few key takeaways notes that should be considered when looking at the figures. First the market capitalization varies extremely among the sample. This can be seen from the min and max values for the size metric and from the differences between the mean and median figures. This indicates that the sample covers a wide range of companies ranging from micro-cap firms to large-cap companies. Second is the low values in the RDA metrics which indicate that even though the sample is biased towards the R&D intensive firms, the overall R&D intensity of the sample is generally very low. However, I find it important to note that the Nordic sample is a lot smaller compared to the US samples and this results in biases in the sample of companies with significant R&D increases towards Chan et al (1990) classification of high technology industries that can be seen from appendix a. I showcase the characteristics of the companies with significant R&D increases in table 2. This sample is the key target group of my study and this shows the key characteristics of the sample companies after the significant R&D increases.

Table 2
Below table shows summary statistics on sample firm characteristics with significant R&D increases listed in Finland, Denmark, Sweden, or Norway. Observation periods starts from 1974 and ends in 2019 and the observation number represents firm year observations. Description of the metrics are the following. RDA measures R&D expenditures relative to the firm's total assets. RevGrwth is the annual revenue growth. Size is the total market capitalization measure in millions of euros. BM is the book to market ratio which is calculated by dividing the shareholder's equity with the market capitalization of the firm. DE measures debt to equity ratio of the firm, the metric is calculated by dividing the total liabilities with the shareholder's equity. Accounting data that was published before initial public offerings were excluded to ensure data quality.

Summary Statistics R&D Increase Sample

Metric	Min	Max	Median	Mean	1st quarter	3rd quarter
RDA	0	2,31	0,1	0,14	0,06	0,16
RevGrwth	-1	207,13	0,03	0,48	-0,04	0,17
Size	0,77	232703,10	125,30	2074,85	39,38	433,6
BM	0	14,19	0,39	0,63	0,21	0,70
DE	0	159,40	0,73	1,32	0,35	1,28

Number of observations = 1345

From table 2 I can see that the distribution of the size metric is roughly the same as in the full sample meaning that the R&D increases are not limited to certain sized companies. Differences arise in the smaller book to market ratio which is consistent with earlier findings that firms with increased R&D intensity have lower book to market values (Chan, Lakonishok: 2001). Firms with high R&D increases seem to have high differences between the revenue growth figure which indicates that they do not differ significantly from the full sample.

It should also be noted that the maximum RDA value is missing from the R&D increase sample which indicates that even though the company has incredibly high R&D intensity, it has not increased suddenly to that high point. This indicates that the Eberhart et al (2004) methodology is able to capture a rather different sample compared to ranking companies by R&D measures. This in turn allows a more specific measurement of the investor reaction to R&D increases as a firm event in addition to a firm attribute.

4. Methodology

4.1 Portfolio Approach

Following Eberhart et al (2004), methodology of using a portfolio approach, I will create equal weighted and value weighted portfolios that comprise of the sample companies. Using this method, I can measure how market reacts to companies that have significant R&D increases on the long run. It is important to note that long-only portfolios have disadvantages of misallocating risk (Fama; 1998, Eberhart, Maxwell, Siddique: 2004) which in turn could translate to abnormal returns. In order to avoid this, I will create a long-short portfolio that is more capable of capturing firm specific risks and characteristics.

As mentioned in the sections 3.2 and 3.3, the definition of companies that have significant R&D increases is a key decision in this thesis. Using this sample that I described earlier in section 3.3, I construct an equal weighted portfolio by including companies that have had a significant R&D increase in the past 60 months. To allow investors price in the information of the R&D increase, I will include a 3-month lag before including a stock in the portfolio (Eberhart, Maxwell, Siddique; 2004). The portfolio is rebalanced monthly.

As shown by the median and the 1st quintile of the sample in table 2, it is reasonable to assume that a large portion of the sample companies are small companies. Therefore, it is salient to create value weighted portfolios to control for the company size. The selection for the value weighted portfolio is identical its equal weighted counterpart. However, there are four different currencies in the Nordics: Swedish Krona, Norwegian Krona, Danish Krona and the Euro. In order to adjust the currency differences, I used end of month exchange rates from Reuters Eikon platform. The value weighted portfolio is rebalanced on a monthly basis.

Equal weighted and value weighted long-short portfolios are created by going long on the R&D increase portfolios and shorting portfolios which are comprised of companies that do not have significant R&D increases within the five-year period. The short stock portfolios are selected from the full sample meaning that the companies that are being shorted do also have R&D expenditures and the same industry exclusions apply to them. These short portfolios are rebalanced monthly in the same way as the long portfolios.

4.2 Measuring Abnormal Returns

I will regress the portfolio returns using Fama French three-factor, Fama French five-factor and Carhart four-factor models (Fama, French; 1993, 2015, Carhart: 1997). In order to capture more exposures to different characteristics, the five-factor model provides additional insight to firm attributes. It should be noted that both regressions will use European level factor data while the excess market returns are taken from AQR's Betting Against Beta data library, momentum factor is also taken from the AQR's Betting Against Beta data library. The excess market return and momentum factor are measured from Swedish markets since the portfolio companies are mostly from Sweden which is shown in appendix b.

I have listed below three-factor and five-factor models. R_{pt} is the portfolio return that includes stocks at a month t if t is within the five year (60 month) period of the significant R&D increase. SMB is the return between portfolios of small stocks and large stocks. HML contains the return of portfolios that have high book to market ratio versus low book to market ratio. RMW is the return difference between stocks that have robust or weak profitability. CMA in turn represents return differences in stocks that invest conservatively versus aggressively while UMD is the return difference in stocks that have performed well and poorly in the past 12 months. (Fama, French; 2015, Carhart: 1997). Risk free rate R_{ft} is the monthly return of US T-bill. For the long short portfolios, the risk-free rate is not needed since it is included in the portfolio return R_{pt}.

Three-Factor Model

$$R_{pt} - R_{ft} = \alpha + b_t(R_{MKTt} - R_{ft}) + s_t SMB_t + h_t HML_t + \varepsilon_t$$

Four-Factor Model

$$R_{pt} - R_{ft} = \alpha + b_t(R_{MKTt} - R_{ft}) + s_t SMB_t + h_t HML_t + u_t UMD_t + \varepsilon_t$$

Five-Factor Model

$$R_{pt} - R_{ft} = \alpha + b_t(R_{MKTt} - R_{ft}) + s_t SMB_t + h_t HML_t + r_t RMW_t + c_t CMA_t + \varepsilon_t$$

5. Results

5.1 Regression results for Equal Weighted and Value Weighted Portfolios

The three-factor and five-factor regression results for equal weighted and value weighted portfolios are found in table 3. The four-factor regression results are found in table 4. Three-factor and four-factor regression results show significant alpha on equal weighted portfolios similar to the results obtained from the US markets (Eberhart, Maxwell, Siddique; 2004). Contrary to the US study, the value weighted portfolios do not present statistically significant returns, although the value weighted do portray economically significant abnormal returns excluding the long-short portfolios.

In addition to the alphas, factor loadings provide additional insights on the companies. The equal weighted portfolio returns seem to be driven by small stocks which is to be expected. However, the positive loading on CMA factor reveals that the equal weighted portfolio firms are also alike to companies that invest conservatively. Value weighted portfolio factor loadings are very different to its equal weighted counterpart. Negative loadings in HML and RMW factors indicate that the large cap stocks have low book to market (high market to book) ratios and that they generally have weak profitability. Negative UMD factor is consistent with earlier findings (Eberhart, Maxwell, Siddique (2004)

To summarize the findings of Fama French factor regressions. It seems that the positive R&D return predictability is not applicable to large cap stocks but instead is present in the smaller stocks. In addition, the large cap stocks with significant R&D increases seem to be growth stocks that exhibit weak profitability. Keeping in mind the heavy high technology industry weight of the portfolios it seems that markets have high confidence in these large cap stocks with significant R&D increases. I hypothesize that this high confidence leads to reduced R&D return predictability. It could be that investors have high confidence to the R&D activity of these large cap stocks whereas this same confidence is absent in the small cap stocks.

Table 3

Below tables represent regression results for equal weighted and value weighted portfolios that measure returns of firms with significant R&D Increases. Intercept measures the abnormal returns (α) generated by the portfolios. Coefficients b, s, h, r & c represent the factor coefficients. Time series length is 354 months. Statistical significance is marked by * -symbols. Five percent significance is marked by a one * -symbol. One percent significance is marked by ** -symbol and zero percent significance is marked by ***-symbol.

Fama French three-factor regression results

Equal Weighted

Coefficient	Value	Std Error	T-Value
Intercept	0,570	0,194	2,945**
b	0,529	0,029	18,343***
s	0,597	0,086	6,961***
h	-0,068	0,057	-1,188

R squared = 0,529

Value Weighted

Coefficient	Value	Std Error	T-Value
Intercept	0,318	0,282	1,126
b	0,519	0,042	12,353***
s	-0,564	0,125	-4,52***
h	-0,641	0,083	-7,699***

R squared = 0,482

Long-Short Equal Weighted

Coefficient	Value	Std Error	T-Value
Intercept	0,318	0,125	2,539**
b	0,054	0,019	2,884**
s	0,153	0,056	2,753**
h	-0,044	0,037	-1,188

R squared = 0,0476

Long-Short Value Weighted

Coefficient	Value	Std Error	T-Value
Intercept	-0,219	0,276	-0,794
b	0,028	0,041	0,683
s	-0,452	0,122	-3,71**
h	-0,631	0,081	-7,755***

R squared = 0,2022

Fama French five-factor regression results

Equal Weighted

Coefficient	Value	Std Error	T-Value
Intercept	0,681	0,206	3,308**
B	0,508	0,033	15,587***
S	0,577	0,087	6,664***
H	-0,052	0,066	-0,785
R	-0,210	0,135	-1,553
C	-0,112	0,141	-0,789

R squared = 0,5326

Value Weighted

Coefficient	Value	Std Error	T-Value
Intercept	0,406	0,300	1,353
b	0,506	0,047	10,664***
s	-0,580	0,126	-4,594***
h	-0,657	0,096	-6,828***
r	-0,209	0,197	-1,061
c	0,020	0,206	0,097

R squared = 0,484

Long-Short Equal Weighted

Coefficient	Value	Std Error	T-Value
Intercept	0,281	0,132	2,13*
b	0,072	0,021	3,436***
s	0,159	0,055	2,875**
h	-0,111	0,042	-2,636**
r	-0,018	0,086	-0,203
c	0,273	0,090	3,013**

R squared = 0,07545

Long-Short Value Weighted

Coefficient	Value	Std Error	T-Value
Intercept	-0,089	0,289	0,306
b	0,025	0,046	0,541
s	-0,476	0,121	-3,918***
h	-0,743	0,093	-8,018***
r	-0,432	0,190	-2,282*
c	0,364	0,198	1,834

R squared = 0,2294

Table 4

Below tables represent regression results for equal weighted and value weighted portfolios that measure returns of firms with significant R&D Increases. Intercept measures the abnormal returns (α) generated by the portfolios. Coefficients b, s, h, & u represent the factor coefficients. Time series length is 354 months. Statistical significance is marked by * -symbols. Five percent significance is marked by a one * -symbol. One percent significance is marked by ** -symbol and zero percent significance is marked by ***-symbol.

Carhart four-factor regression results

Equal Weighted

Coefficient	Value	Std Dev	T-Value
Intercept	0,694	0,192	3,619***
b	0,501	0,029	17,229***
s	0,609	0,084	7,262***
h	-0,062	0,056	-1,115
u	-0,132	0,032	-4,103***

R squared = 0,5509

Value Weighted

Coefficient	Value	Std Dev	T-Value
Intercept	0,509	0,278	1,828
b	0,475	0,042	11,258***
s	-0,545	0,122	-4,473***
h	-0,633	0,081	-7,787***
u	-0,203	0,047	-4,362***

R squared = 0,5088

Long-Short Equal Weighted

Coefficient	Value	Std Dev	T-Value
Intercept	0,369	0,126	2,926**
b	0,042	0,019	2,215*
s	0,158	0,055	2,865**
h	-0,042	0,037	1,135
u	-0,053	0,021	-2,54*

R squared = 0,06489

Long-Short Value Weighted

Coefficient	Value	Std Dev	T-Value
Intercept	0,008	0,269	0,030
b	-0,024	0,041	0,593
s	-0,429	0,117	-3,656***
h	-0,621	0,078	-7,925***
u	-0,241	0,045	-5,361***

R squared = 0,2629

5.2 Regression Results for Subsamples

Chan et al (2001) show that positive return predictability only exists in tech companies with poor past performance meaning that the positive return predictability is only applicable to these companies. It is salient to look at the sample firm performance before significant R&D increases to see whether there is underperformance that could cause the positive return predictability, in addition I will regress a low tech subsample to see if the R&D return predictability is applicable to them, since there exists empirical evidence that abnormal returns are lower for non-high technology stocks (Eberhart, Maxwell, Siddique: 2004). The regression results are showcased in tables four and five. The firms do not experience abnormal returns before R&D increases, which contradicts the poor performance theory (Chan, Lakonishok, Sougiannis: 2001).

However, I find that subsample portfolios excluding high technology stocks do not experience any significant abnormal returns albeit they are economically significant. I interpret these results so that investors react to R&D increases in non-high technology stocks correctly and these results show consistency with the reference literature (Chan, Lakonshikok, Sougiannis: 2001, Eberhart, Maxwell, Siddique: 2004).

Table 5

Below tables represent regression results for equal weighted and value weighted portfolios that test firm performance 36 months before the R&D increases. Intercept measures the abnormal returns (α) generated by the portfolios. Coefficients b, s, h, r & c represent the factor coefficients. Time series length is 343 months. Statistical significance is marked by * -symbol. Five percent significance is marked by a one * -symbol. One percent significance is marked by ** -symbol. and zero percent significance is marked by ***-symbol.

Fama French three-factor regression results

Equal Weighted pre R&D increase

Coefficient	Value	Std Error	T-Value
Intercept	0.597	0.232	1,931
b	0.619	0,027	16,601***
s	0.550	0,080	6,623***
h	0.160	0,054	-0,361

R squared = 0,5344

Value Weighted pre R&D increase

Coefficient	Value	Std Error	T-Value
Intercept	0,899	0,523	1,719
b	0,725	0,077	9,372***
s	-0,976	0,230	-4,245***
h	-0,738	0,153	-4,827***

R squared = 0,3475

Long-Short Equal Weighted pre R&D increase

Coefficient	Value	Std Error	T-Value
Intercept	0,328	0,179	1,830
b	0,148	0,026	5,57***
s	0,090	0,079	1,137
h	-0,145	0,052	-2,761**

R squared = 0,1289

Long-Short Value Weighted pre R&D increase

Coefficient	Value	Std Error	T-Value
Intercept	0,334	0,502	0,666
b	0,264	0,074	3,558***
s	-0,861	0,221	-3,900***
h	-0,786	0,147	-5,352***

R squared = 0,1896

Table 6

Below tables represent regression results for equal weighted and value weighted portfolios that test ex high tech high R&D firm performance. Intercept measures the abnormal returns (α) generated by the portfolios. Coefficients b, s, h, r & c represent the factor coefficients. Time series length is 354 months. Statistical significance is marked by * -symbol. Five percent significance is marked by a one * -symbol. One percent significance is marked by ** -symbol and zero percent significance is marked by ***-symbol.

Fama French three-factor regression results

Equal Weighted ex high tech

Coefficient	Value	Std Error	T-Value
Intercept	0,350	0,181	1,931
b	0,449	0,027	16,601***
s	0,532	0,080	6,623***
h	-0,019	0,054	-0,361

R squared = 0,4762

Value Weighted ex high tech

Coefficient	Value	Std Error	T-Value
Intercept	0,203	0,193	1,051
b	0,297	0,029	10,311***
s	0,015	0,086	0,171
h	0,173	0,057	3,02**

R squared = 0,2345

Long-Short Equal Weighted ex high tech

Coefficient	Value	Std Error	T-Value
Intercept	0,062	0,138	0,451
b	-0,034	0,020	-1,686
s	0,080	0,061	1,315
h	-0,003	0,040	-0,074

R squared = 0,01558

Long-Short Value Weighted ex high tech

Coefficient	Value	Std Error	T-Value
Intercept	0,338	0,195	1,730
b	0,196	0,029	6,764***
s	0,124	0,086	1,448
h	0,181	0,057	3,172**

R squared = 0,189

6. Robustness Checks

6.1 Risk Based Explanation for Return Predictability

Since the results I have obtained in the section five using factor models show some level of return predictability, I find it salient to test whether this predictability is explained by the increased risk in R&D intensive firms. Gu (2015) shows that the positive R&D return predictability is caused by increased exposure to systematic firm. This increased systematic risk results from the fact that when firms enter innovation races, a large part of the firm value is tied into the future cash flows that rely on the R&D project.

It should be noted that there exists evidence between distress risk, financial constraints and R&D return predictability (Li: 2011, Gu: 2015), but these studies treat R&D as a firm attribute, while in this study I am interested in measuring the effects of R&D increases (investments). Therefore, distress risk and constraints approaches are not directly applicable to this study.

I will measure the exposure by comparing bear market subsamples. It should be reasonable to assume that if the systematic risk approach is correct, the sample firms should experience large exposures to market risk or underperformance since the firm value is largely tied to prospects in the future. I define a bear market as a two-year period following a -20% market return. I regress this sub sample to the market returns to estimate betas during bear market with the following model. Where Bear is a dummy variable that equals to 1 if markets have had a -20% return within 24 months.

$$Bear_t(R_{pt} - R_{ft}) = \alpha + \ Bear_t \ b_t\big(R_{MKTt} - R_{ft}\big) + \ \varepsilon_t$$

The results are showcased in table 6. It should be noted that the control portfolios include stocks that have had R&D expenses which means that the sample is skewed towards high-tech stocks similar to the sample portfolios. I find that the sample portfolios have around 2,7 percent larger market betas, but this difference is minimal.

Table 7
Below tables represent regression results for equal weighted and value weighted portfolios that test sample firm exposure to market risk and performance during stock market turmoil (bear market). Intercept measures the abnormal returns (α) generated by the portfolios. Coefficient b represents market beta. Time series length is 354 months and bear market month observation length were 48 months. Statistical significance is marked by * -symbol. Five percent significance is marked by a one * -symbol. One percent significance is marked by ** -symbol and zero percent significance is marked by ***-symbol.

Market Betas and Return Comparisons During Bear Market

Equal Weighted

Coefficient	Value	Std Dev	T-Value
Intercept	0,033	0,097	0,335
b	0,383	0,030	12,714***

R squared = 0,3147

Value Weighted

Coefficient	Value	Std Dev	T-Value
Intercept	-0,110	0,104	-1,066
b	0,433	0,032	13,511***

R squared = 0,3415

Control Equal Weighted

Coefficient	Value	Std Dev	T-Value
Intercept	-0,059	0,070	-0,841
b	0,373	0,022	17,293***

R squared = 0,4593

Control Value Weighted

Coefficient	Value	Std Error	T-Value
Intercept	0,003	0,058	0,047
b	0,421	0,018	23,442***

R squared = 0,6084

Long Short Equal Weighted

Coefficient	Value	Std Error	T-Value
Intercept	0.091	0.049	1.853
b	0.01	0.015	0.661

R squared = 0,0012

Long Short Value Weighted

Coefficient	Value	Std Error	T-Value
Intercept	-0.113	0.09	-1.256
b	0.012	0.028	0.435

R squared = 0,00053

In addition to the market betas, I estimated returns for long-short portfolios. I find that the equal weighted portfolio does not underperform the control group, but the value weighted portfolio seems to have slight underperformance. These results do not indicate that the R&D intensive firms are exposed to increased risk, and the value weighted underperformance is consistent with the growth firm characteristics.

6.2 Accounting Standardization Subsamples

As mentioned in the section 3.1, the sample has outlier values situated in the year 2005 that can be seen from the chart in appendix c. This outlier arises likely from the mandatory adoption of IAS/IFRS standards in the European Union. This adoption likely affects the sample companies reporting of R&D and other accounting figures and the new standards may not be comparable to the pre-2005 R&D sample. To test if the samples are vastly different, I run regressions on two subsamples on years 1990-2004 and 2005-2019.

Table 8

Below tables represent regression results for equal weighted and value weighted portfolios that test sample firm performance during two distinctive periods. Time series period is specified in the header above regression results. Intercept measures the abnormal returns (α) generated by the portfolios. Coefficients b, s, h, r & c represent the factor coefficients. Time series lengths are 180 & 174 months for the 1990-2004 & 2006-2019 samples, respectively. Statistical significances are marked by * -symbols. Five percent significance is marked by a one * -symbol. One percent significance is marked by ** -symbol and zero percent significance is marked by ***-symbol.

Fama French three-factor regression results

1990 – 2004 Equal Weighted

Coefficient	Value	Std Error	T-Value
Intercept	0,612	0,311	1,985*
b	0,603	0,046	13,092***
s	0,456	0,123	3,733***
h	-0,030	0,078	0,574

R squared = 0,5311

1990 – 2004 Value Weighted

Coefficient	Value	Std Error	T-Value
Intercept	0,755	0,462	1,633
b	0,667	0,068	9,754***
s	-0,780	0,182	-4,393***
h	-0,571	0,115	-4,969***

R squared = 0,581

2005-2019 Equal Weighted

Coefficient	Value	Std Error	T-Value
Intercept	0,576	0,229	2,518*
b	0,447	0,036	12,374***
s	0,772	0,117	6,585***
h	0,047	0,104	0,447

R squared = 0,4128

2005-2019 Value Weighted

Coefficient	Value	Std Error	T-Value
Intercept	-0,02	0,304	-0,075
b	0,349	0,048	7,260***
s	-0,311	0,156	-1,993*
h	-0,422	0,139	-3,041**

R squared = 0,2835

Table 7 results show that the subsample portfolios do generate significant abnormal returns for equal weighted portfolios in both periods. However, the value weighed portfolio during the period 2005-2019 generates slightly negative returns. I do not find this slightly negative return concerning since it does not contradict the results obtained in section 5. In addition, decreased observation periods are likely too short for long-term return measurement especially when I consider the five-year holding periods for the stocks. Therefore, I find it likely that the lower abnormal return of the value weighted subsample portfolio is likely caused by a decreased observation period and it does not contradict the earlier results.

7. Conclusions

Do investors misprice increased R&D expensed in the Nordics? In this study I tried to answer this question by following Eberhart et al (2004) methodology of measuring long term abnormal returns in companies that have had sudden and significant R&D increases. My main hypothesis in this study was that investors misprice R&D increases due to the intangible nature of the benefit that these investments provide which leads to positive R&D return predictability.

My results provide evidence that firms with unexpected and significant R&D increases generate positive abnormal returns when the holding period for these firms is 60 months in the portfolio. However, the positive R&D return predictability is not observed in all companies. Value weighted portfolios that have increased exposure to large cap firms are not able to generate positive abnormal returns for companies with R&D increases. Additionally, the sample portfolios are heavily skewed towards technology and healthcare industries which can be considered high technology industries (Chan, Martin, Kensinger: 1990). When I exclude the high technology companies from the sample portfolios, I do not find any significant abnormal returns, albeit the returns can be considered economically significant. Portfolio performance preceding R&D increases is not significantly negative nor positive which indicates that the underreaction is not limited to poor performing technology companies (Chan, Lakonishok: 2001).

Deducing from these results, I cannot accept my hypothesis **H1** of investor underreaction to be applicable to all companies. It seems that markets are able to value large cap and non high technology companies correctly. However, I cannot reject my hypothesis either, since the significant and consistent abnormal returns in equal weighted portfolios show that investor underreaction seems to be present in smaller companies that operate in high technology industries. Therefore, my hypothesis **H1** is applicable to small and mid cap companies only.

It seems that Nordic markets treat R&D projects differently among different size firms. The lack of abnormal returns in large cap firms could mean that investors have higher confidence in their capability of creating successful innovations through R&D increases, this confidence is then priced in the stock prices which is shown by the low book to market ratios. This same reaction cannot be observed in the smaller companies, which means that investors underestimate the future benefits of R&D projects in these companies. This underreaction is reflected by higher book to market ratios and the significant abnormal returns. Compared to international results, it seems that Nordic investors do have a more optimistic stance towards R&D investments in large high technology companies.

In addition to the size factor, it seems that the R&D return predictability is industry specific. Positive R&D return predictability was shown only in the equal weighted portfolio that skews towards high technology industries. This implicates that investors find high technology R&D projects harder to value in high technology industries, which seems to be rather intuitive.

My results and conclusions are consistent with the latest empirical literature (Chan, Martin, Kensinger: 1990, Chan, Lakonishok, Sougiannis: 2001, Eberhart, Maxwell, Siddique: 2004, Cohen, Diether, Malloy: 2013). However, I find my results to be inconsistent with the risk-based explanation of the R&D return predictability (Gu: 2015, Zhang: 2015). I find the decreased book to market characteristics of large cap companies consistent with Titman & Daniel (2006) findings.

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9. Appendix

Appendix A

Below table shows the industry distribution of the sample companies. The company industry is based on Thomson Business Classification. It should be noted that financials classification includes companies that participate in producing financial applications or technology. Thomson Business Classification was not available to all sample companies. High technology are classified using Chan et al (1990) methodology and these industries have "Y" mark next to them in High Technology column.

Distribution of sample stocks between industries

Industry	Share of Sample Firms	High Technology
Energy	1,13 %	N
Basic Materials	4,52 %	N
Industrials	19,21 %	N
Cyclical Consumer Goods & Services	7,34 %	N
Non-Cyclical Consumer Goods & Services	2,82 %	N
Financials	2,82 %	N
Healthcare	35,03 %	Y
Technology	25,99 %	Y
Utilities	1,13 %	N

Appendix B

Below table shows the industry distribution of the sample companies. The company industry is based on Thomson country Classification.

Distribution of sample stocks between countries

Country	
Finland	18,55 %
Sweden	45,70 %
Denmark	13,12 %
Norway	22,62 %

Appendix C

Below graph shows the average annual growth of R&D/Sales Metric for the sample companies.